SILICON CARBIDE (SiC)

The Hidden Gem Powering the Electric Vehicle Revolution

An In-Depth Analysis for the General Reader

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1. Introduction: The Quiet Revolution Under the Hood

Every time you plug in an electric vehicle or watch a solar panel send power to the grid, something extraordinary is happening inside a tiny piece of material that most people have never heard of. That material is Silicon Carbide, or SiC for short. It is not the battery. It is not the motor. But without it, modern electric vehicles would be slower to charge, shorter in range, and far less efficient.

Silicon Carbide is what engineers call a wide bandgap semiconductor. In plain language, it is a special type of crystal made from just two common elements, silicon and carbon, that can handle far more heat, voltage, and speed than ordinary silicon chips. It is this combination of superhuman electrical abilities packed into a tiny device that is making Silicon Carbide one of the most sought-after industrial materials of the 21st century.

> **Why it matters:** *The global SiC market, valued at approximately USD 4.28 billion in 2024, is projected to reach USD 110 billion by 2034, a staggering growth rate of 34.5% per year. This is not a niche curiosity. This is the material that will help define the clean energy economy.*

Yet despite its incredible importance, Silicon Carbide remains largely unknown outside engineering circles. This article sets out to change that, explaining what SiC is, where it comes from, why it matters, and what the future holds, in language that anyone can understand.

2. What Exactly Is Silicon Carbide?

2.1 The Basic Science, Explained Simply

At its simplest, Silicon Carbide is a compound made from two elements you already know: silicon, the same material used in regular computer chips, and carbon, the same element found in pencil graphite and diamonds. When these two elements are bonded together under extreme heat of over 2,000 degrees Celsius, they form a crystal with properties that are simply extraordinary.

Imagine a material that is nearly as hard as diamond, scoring 9 to 9.5 on the Mohs hardness scale where diamond is 10. It can survive temperatures above 1,600 degrees Celsius without losing strength, conducts electricity far more efficiently than regular silicon, and does all of this in a package that can be made incredibly small and light. That is Silicon Carbide.

2.2 The Key Difference: Wide Bandgap

The most important technical concept to understand is the bandgap. Think of bandgap as a hurdle that electrons, the tiny particles that carry electricity, need to jump over. The higher the hurdle, the harder it is for stray electrons to cross, meaning the material can handle higher voltages without breaking down.

Regular silicon has a bandgap of 1.12 electron volts (eV). Silicon Carbide has a bandgap of 3.26 eV, nearly three times higher. This means SiC devices can handle voltages roughly ten times higher than silicon, operate at far higher temperatures without needing costly cooling systems, switch on and off much faster which directly improves efficiency, and waste far less energy as heat.

> **Simple analogy:** *If silicon is a regular car that works well on smooth roads, Silicon Carbide is a heavy-duty truck that can tackle motorways, steep mountain passes, and desert heat without overheating or breaking down.*

3. The Fascinating History of Silicon Carbide

3.1 Accidentally Discovered in a Lab

The story of Silicon Carbide begins in 1891, in the laboratory of an American inventor named Edward G. Acheson. Acheson was not looking for Silicon Carbide; he was trying to make artificial diamonds. Instead, he discovered a hard, gritty substance he named carborundum. It turned out to be SiC, and he immediately recognised its commercial potential as an abrasive that could grind, cut, and polish other materials.

Two years later, in 1893, French chemist Henri Moissan found tiny traces of naturally occurring Silicon Carbide in a meteorite crater in Arizona. This natural form is now called moissanite in his honour and is used as a gemstone in jewellery. But natural moissanite is vanishingly rare, and virtually all Silicon Carbide used industrially and commercially is man-made.

3.2 From Sandpaper to Semiconductors

For most of the 20th century, Silicon Carbide was mainly used as an abrasive in sandpaper, grinding wheels, and cutting tools. Its hardness made it perfect for these applications, and the furnace-based manufacturing method Acheson developed remained standard for over a century.

The semiconductor revolution began slowly. As early as 1907, scientists discovered electroluminescence in SiC, the ability to emit light when electricity passes through it, which led to some of the world's first LEDs. Progress was limited for decades by the difficulty of growing pure, defect-free SiC crystals. It was not until the 1980s and 1990s that breakthroughs in crystal growth technology allowed scientists to create high-quality SiC wafers suitable for advanced electronics. NASA's Glenn Research Center was among the earliest champions, funding SiC research from around 1980 to develop sensors and circuits for extreme aerospace environments.

3.3 Tesla Changes Everything

The modern Silicon Carbide story has one clear landmark moment: 2018, when Tesla launched the Model 3. For the first time in a mass-production vehicle, Tesla used Silicon Carbide MOSFETs in the car's power inverter, the device that converts battery DC power into AC power for the motor. The result was a significant improvement in efficiency, range, and performance. The automotive world took notice, and the race to adopt SiC was on.

4. How Does SiC Work in an Electric Vehicle Charger?

4.1 Understanding the EV Power Chain

To understand why SiC matters so much in EV charging, it helps to understand how electricity flows in an electric vehicle. When you plug in your car, AC (alternating current) electricity from the grid must be converted to DC (direct current) to charge the battery. This conversion happens in the On-Board Charger (OBC). Once stored in the battery, DC power must be converted back to AC to drive the electric motor through the traction inverter. A DC-DC converter manages power between different systems in the car. Every one of these conversions involves some energy loss, and SiC minimises those losses dramatically.

4.2 SiC in the On-Board Charger

In a traditional silicon-based on-board charger, the device operates at relatively low switching frequencies, generates significant heat, and requires bulky cooling systems. Replace those components with SiC MOSFETs and SiC Schottky diodes and the results are dramatic. SiC components switch on and off several times faster, meaning less energy is wasted in each cycle. SiC devices run cool even at high power levels, reducing the need for heavy cooling. The entire charger can be made smaller and lighter. And charging efficiency improves measurably.

> **Real-world impact:** *SiC-based on-board chargers achieve efficiency levels above 98%, compared to around 95% for silicon-based designs. Charged thousands of times over a vehicle's lifetime, this difference translates to hundreds of dollars in electricity savings for the owner.*

4.3 SiC in Fast-Charging Stations

Beyond the car itself, SiC is equally transformative in roadside DC fast-charging stations. These stations must convert very high-voltage AC grid power to precisely controlled DC power at 400V or 800V and deliver it to the car as quickly as possible. SiC power modules handle this with far greater efficiency and reliability than silicon alternatives, resulting in faster charging, cooler-running equipment with longer service life, and lower electricity bills for station operators.’

5. The Extraordinary Properties of Silicon Carbide

A summary of why Silicon Carbide outperforms regular silicon in demanding applications:

- Bandgap of 3.26 eV versus 1.12 eV for silicon, allowing operation at much higher voltages
- Breakdown electric field approximately 10 times higher than silicon, resisting electrical breakdown
- Thermal conductivity of 100 to 490 W/m per kelvin, dissipating heat with exceptional efficiency
- Maximum operating temperature above 600 degrees Celsius, versus around 150 degrees for silicon

- Hardness of 9 to 9.5 on the Mohs scale, one of the hardest synthetic materials known to science
- Electron saturation velocity approximately twice that of silicon, enabling ultra-fast switching
- High radiation hardness, making it ideal for space, nuclear, and defence applications

These are not incremental improvements over silicon. They represent a fundamentally different class of material, which is why engineers speak of SiC as a third-generation semiconductor, following germanium (first generation) and silicon (second generation).

6. Who Uses Silicon Carbide? Key Industries

6.1 Electric Vehicles: The Biggest Driver

The automotive industry currently accounts for the lion's share of SiC demand and this will only intensify. Every major automaker including Tesla, Toyota, General Motors, BMW, Volkswagen, Hyundai, and Kia is transitioning to SiC-based power electronics. Infineon Technologies has secured a multi-year supply agreement with Hyundai Motor Company and Kia for SiC semiconductors. Wolfspeed announced in December 2025 that its SiC MOSFETs will power on-board charger systems for Toyota's Battery Electric Vehicles. STMicroelectronics unveiled its fourth-generation SiC MOSFET platform in 2024, targeting not just premium EVs but mid-size and compact vehicles by 2025. The automotive and mobility segment is expected to retain roughly 70% of all SiC demand over the next five years.

6.2 Renewable Energy: Solar and Wind

Solar inverters, the devices that convert DC electricity from solar panels into AC for the grid, are one of the largest industrial applications for SiC. SiC-based inverters can switch at two to three times the frequency of silicon designs, allowing circuit components to be made smaller and cheaper. The resulting inverter can be nearly half the size and weight of a conventional silicon design, with higher efficiency and longer operating life. Wind power generation and battery energy storage systems similarly benefit from SiC's high-power, high-efficiency characteristics.

6.3 Defence and Aerospace

NASA has been a champion of SiC technology since approximately 1980, investing in SiC research precisely because the material functions in extreme environments that destroy ordinary electronics. SiC circuits have been demonstrated operating at temperatures above 600 degrees Celsius. Military radar systems, missile guidance electronics, jet engine control systems, and spacecraft all benefit from SiC's radiation hardness and thermal resilience. India's own SEMICON India 2025 government policy document specifically highlights SiC as critical for defence systems, missiles, radars, and rockets in space.

6.4 Industrial Power Electronics

Motor drives used in industrial machinery, lifts, and conveyor systems, uninterruptible power supplies (UPS), smart grid infrastructure, railway traction systems, and data centre power supplies all increasingly rely on SiC devices. In data centres alone, analysts project a USD 200 million opportunity for SiC over the next five years, driven by the energy demands of artificial intelligence computing.

6.5 Telecommunications and 5G

The rollout of 5G networks requires base stations that handle high frequencies and high power loads with maximum efficiency. SiC devices meet these requirements with room to spare, making them a preferred choice for next-generation telecom infrastructure.

6.6 Medical and Nuclear Applications

In medical equipment, SiC's biocompatibility and extreme hardness make it suitable for implantable devices and surgical tools. In the nuclear industry, SiC composite materials are being investigated as cladding for nuclear fuel rods because SiC does not suffer the hydrogen embrittlement that degrades traditional zirconium alloy cladding at high temperatures.

7. The Growth Story: From Abrasive Grit to a $110 Billion Market

7.1 Market Size and Projections

The numbers tell a remarkable story. The global Silicon Carbide market was valued at approximately USD 4.28 billion in 2024. According to Zion Market Research, it is projected to reach USD 110.42 billion by 2034, implying a CAGR of around 34.5%. Global Market Insights reports the SiC market exceeded USD 5.5 billion in 2025 and forecasts a similar CAGR through 2034. The SiC device market alone is projected to reach USD 10.3 billion by 2030, according to Yole Group. These are not speculative figures driven by hype; they are anchored in firm orders, long-term supply agreements, and government mandates for EV adoption across Europe, the United States, India, and China.

7.2 Key Market Milestones

Growth accelerated sharply after Tesla's 2018 Model 3 launch. Between 2018 and 2022, projections for global EV market share in 2030 nearly quadrupled, and SiC demand projections rose alongside them. The EV market itself is estimated to grow at 20% CAGR through 2030, when annual EV sales are expected to reach 64 million vehicles, roughly four times the 2022 figure. More than 3 million EVs were sold in just the first half of 2024, a year-on-year increase of around 25%.

A critical technology transition is underway in SiC manufacturing: the move from 6-inch to 8-inch wafers. Larger wafers produce more chips per production run, lower cost per chip, and enable the scale needed for automotive volumes. Wolfspeed leads this transition, with 50% market penetration of 8-inch wafers expected by 2030.

7.3 The Key Global Players

The SiC industry is dominated by companies that have invested billions in manufacturing capacity: Wolfspeed (USA), the self-described pioneer of SiC; Infineon Technologies (Germany); STMicroelectronics (Switzerland and France); onsemi (USA); ROHM Semiconductor (Japan); Mitsubishi Electric (Japan); Bosch (Germany); Microchip Technology (USA); and Toshiba (Japan). onsemi acquired SiC JFET assets from Qorvo in December 2024, broadening its portfolio. ROHM launched new high-power-density SiC modules targeting on-board chargers in April 2025. The market is intensely competitive.

8. India's Silicon Carbide Ambitions: A Nation Waking Up

8.1 The India Semiconductor Mission

India is building its semiconductor manufacturing capability from the ground up, and Silicon Carbide is central to that effort. The India Semiconductor Mission (ISM), launched in December 2021, provides fiscal support of up to 50% of project costs for compound semiconductor fabrication facilities, the category that covers SiC. As of December 2025, 10 semiconductor projects with a combined investment of Rs 1.60 lakh crore have been approved across six Indian states, according to official government sources. The Indian semiconductor market itself is expected to reach USD 100 to 110 billion by 2030.

The Ministry of Electronics and Information Technology (MeitY) has identified SiC wafer manufacturing as a strategic priority under India Semiconductor Mission 2.0, specifically to reduce import dependence and serve the booming domestic EV market.

8.2 India's First Silicon Carbide Fab: The Odisha Story

On August 12, 2025, the Union Cabinet approved India's first commercial Silicon Carbide fabrication plant. Located in Odisha, SiCSem Private Limited, in collaboration with UK-based Clas-SiC Wafer Fab Ltd., will build a facility with annual capacity of 60,000 SiC wafers and 96 million packaged units. This facility specifically targets EV charging and high-performance computing applications.

Additionally, Odisha's state government extended fiscal support to RIR Power Electronics Limited for a Rs 618 crore SiC semiconductor manufacturing project in Bhubaneswar. This plant will produce high-voltage SiC components for EVs, renewable energy systems, and industrial automation, and is expected to create around 750 direct and indirect jobs.

> **India's strategic leap:** *Rather than competing head-to-head with Taiwan and South Korea in mature silicon chip manufacturing, India is strategically leapfrogging into compound semiconductors, a niche where it can build global leadership from the ground up.*

8.3 A Pan-India Semiconductor Effort

Punjab is also receiving SiC-related investments. The Design Linked Incentive (DLI) scheme has sanctioned 23 chip design projects nationwide. In May 2025, 3-nanometre chip design facilities were inaugurated in Noida and Bengaluru. At Semicon India 2025, IT Minister Ashwini Vaishnaw presented India's first fully indigenous microprocessor, the VIKRAM 3201, developed by ISRO's Semiconductor Lab in Chandigarh. India aims to design and manufacture chips for 70 to 75% of domestic applications by 2029, and under ISM 2.0, targets becoming a top-5 global semiconductor power by 2035.

9. Upcoming Projects and Global Investments

9.1 Wolfspeed's Expansion

Wolfspeed opened a major SiC production facility in upstate New York in 2022 and has been aggressively expanding. The December 2025 announcement that Toyota will use Wolfspeed SiC MOSFETs in its BEV on-board charger systems is a powerful endorsement from one of the world's most quality-focused automakers. Wolfspeed also has a wafer supply agreement with Renesas Electronics to scale SiC power semiconductor production.

9.2 STMicroelectronics: Generation 4 SiC Technology

STMicroelectronics completed qualification of its Generation 4 SiC MOSFET technology in late 2024 and began commercial availability of 750V and 1200V devices in 2025. The company plans further SiC technology innovations through 2027, specifically targeting the large market of mid-size and compact EVs with affordable SiC benefits.

9.3 Hyundai-Infineon Partnership

In March 2025, Hyundai Motor Company expanded its partnership with Infineon Technologies for co-development of power semiconductors including SiC devices for EV programmes. Infineon has also secured a multi-year supply agreement with Kia for SiC and silicon power modules, with financial contributions from Kia and Hyundai to support Infineon's capacity build-up.

9.4 US CHIPS Act and Allied Investments

The US CHIPS Act is directing billions of dollars into domestic semiconductor manufacturing. Texas Instruments secured USD 1.6 billion for fabs in Utah and Texas. TSMC plans to invest USD 100 billion in five new US fabrication plants. In August 2025, new tariff measures were announced to further encourage domestic production. These broad investments in semiconductor infrastructure strengthen the overall SiC supply chain.

10. Challenges: Headwinds Facing Silicon Carbide

Despite enormous potential, Silicon Carbide faces real challenges that are shaping its adoption:

- High Cost: SiC wafers cost significantly more than silicon wafers to produce, because growing high-quality SiC crystals requires sustained temperatures above 2,000 degrees Celsius and is technically very difficult. This cost premium is falling but remains a barrier in price-sensitive applications.
- Supply Constraints: Until recently, SiC supply was concentrated among a small number of manufacturers, creating bottlenecks. The automotive industry's rapid scaling has at times outpaced supply chain growth.
- Manufacturing Complexity: Producing defect-free SiC crystals at scale is far harder than silicon. The transition to 8-inch wafers, while

underway, brings new yield challenges that manufacturers are actively working to overcome.

- Short-Term EV Demand Fluctuation: A temporary softness in EV sales in 2024 caused some automotive customers to pause SiC orders briefly. This is broadly viewed as a short-term correction, not a structural reversal of the EV transition.
- Competition from Gallium Nitride (GaN): GaN is another wide bandgap semiconductor that competes with SiC in some lower-voltage consumer applications. However, SiC maintains clear advantages in the high-voltage automotive and industrial applications that dominate the market.

11. The Future Outlook: What Lies Ahead

11.1 A $110 Billion Market by 2034

The consensus among market analysts and industry strategists is unambiguous: Silicon Carbide is moving from a speciality material to an industrial staple. The transition of the global automotive fleet to electric vehicles is the single most powerful driver, but SiC's expansion into renewable energy, data centres, defence, and telecommunications ensures sustained growth regardless of short-term fluctuations in any single sector.

11.2 The 800-Volt Revolution

The industry-wide shift to 800-volt EV architectures, which charge roughly twice as fast as current 400-volt systems, is a structural tailwind for SiC. Only SiC devices can efficiently handle 800-volt systems at the required operating temperatures and power levels. Porsche, Hyundai, Kia, and Audi have already launched 800V EVs, and the rest of the industry is following. More 800V model launches directly translate to higher SiC content per vehicle.

11.3 Wireless EV Charging: The Next Frontier

The SiC wireless EV charging market, though still small at USD 4.2 million in 2024, is projected to grow at 15.1% CAGR through 2034, reaching USD 17 million. As inductive wireless charging technology matures for parking bays and even roads, SiC's ability to handle high-frequency power transfer with minimal energy loss makes it the preferred semiconductor for wireless charging systems.

11.4 Data Centres and AI Infrastructure

The explosion of artificial intelligence computing has created enormous demand for data centre power. SiC is increasingly the semiconductor of choice for high-efficiency power supplies and UPS systems in these facilities.

11.5 India's Strategic Opportunity

For India, the SiC story is particularly exciting. The country is simultaneously one of the world's fastest-growing EV markets and a nation building its first SiC fabrication capacity. If the projects in Odisha, Punjab, and elsewhere reach full production, India could supply a meaningful share of Asia-Pacific's SiC demand by the late 2020s. SiC wafer manufacturing is explicitly named a strategic national priority under ISM 2.0.

11.6 The Environmental Dividend

Perhaps the most underrated dimension of SiC's future is its environmental contribution. Every SiC chip that replaces a silicon chip in an EV charger, solar inverter, or industrial motor drive reduces energy losses. At scale, across hundreds of millions of devices worldwide, this adds up to an enormous reduction in electricity consumption and carbon emissions. Silicon Carbide is not merely a semiconductor. It is one of the key enabling technologies of the global energy transition.

12. Conclusion: The Unsung Hero of the Clean Energy Era

Silicon Carbide started life as an accident, a gritty byproduct of a chemist's quest for artificial diamonds. Today, it is one of the most strategically important materials in the world, quietly enabling the global transition to electric vehicles, renewable energy, and efficient power systems.

It is harder than almost any other synthetic material. It operates at temperatures that would destroy conventional electronics. It is three times more electrically capable than silicon. And it makes electric vehicles charge faster, travel further, and waste less energy, every single charge.

The market trajectory, from USD 4.28 billion in 2024 to a projected USD 110 billion by 2034, speaks for itself. India is building its first SiC fabs and placing Silicon Carbide at the heart of its semiconductor strategy. The world's largest automakers from Toyota to Hyundai are locking in long-term SiC supply deals. NASA has championed it for space applications for over four decades.

Silicon Carbide is no longer a hidden gem. It is an industrial treasure. And its best days are very much still ahead.

References and Source Material

The following credible sources, including government policy documents, industry research, and academic material, were consulted for this article.

Government and Official Policy Sources

1. Press Information Bureau, Govt. of India. India Semiconductor Mission 2.0. February 2026. pib.gov.in

2. SEMICON India 2025 Official Document, Ministry of Electronics & IT (MeitY). September 2025. pib.gov.in / static.pib.gov.in

3. India Semiconductor Mission Overview. India Science and Technology Portal. indiascienceandtechnology.gov.in

4. NASA Glenn Research Center. Silicon Carbide Electronics and Sensors. nasa.gov/glenn

5. US Department of Energy, Office of Energy Efficiency & Renewable Energy. SiC programme references.

6. AIChE (American Institute of Chemical Engineers). A Novel, Low-Cost Sustainable Process to Produce Silicon Carbide. Chemical Engineering Progress, October 2022.

Market Research and Industry Reports

7. Zion Market Research. Global Silicon Carbide (SiC) Market Size, Share & Forecast 2025-2034. June 2025. zionmarketresearch.com

8. Global Market Insights. Silicon Carbide Market Size, Growth Trends 2026-2034. gminsights.com

9. Global Market Insights. Silicon Carbide for Wireless EV Charging Market 2025-2034. gminsights.com

10. Research and Markets. Silicon Carbide (SiC) for Wireless EV Charging Market 2025-2034. researchandmarkets.com

11. MarketsandMarkets. EV Semiconductors Market, USD 57.48 Billion by 2032. marketsandmarkets.com

12. McKinsey & Company Semiconductor Practice. New Silicon Carbide Prospects Emerge as Market Adapts to EV Expansion. October 2023. mckinsey.com

13. Yole Group. Power SiC: Market & Applications 2025 Report. June 2025. yolegroup.com

Company and Technology Sources

14. Wolfspeed Inc. Wolfspeed Powers Toyota's Electric Vehicle Platforms with Silicon Carbide Components. Press Release, December 9, 2025. wolfspeed.com

15. STMicroelectronics. Fourth Generation STPOWER Silicon Carbide MOSFET Technology. Press Release, September 24, 2024. newsroom.st.com

16. Microchip Technology. Understanding Silicon Carbide: The Game-Changer in Power Electronics. August 2024. microchip.com

17. Navitas Semiconductor / GeneSiC. Silicon Carbide: The Facts. navitassemi.com

18. Arrow Electronics. What Is Silicon Carbide (SiC)? Uses and How It Is Made. arrow.com

India-Specific Sources

19. India Briefing / Dezan Shira & Associates. India Approves Four Semiconductor Projects Worth US$524M. August 12, 2025. india-briefing.com

20. India Briefing. Semiconductor Industry in India: Incentives and Key Players. January 2026. india-briefing.com

21. EQ International Media Network. Odisha Supports Rs 618 Crore Silicon Carbide Semiconductor Plant, a First for India. eqmagpro.com

22. Evrimagaci. India Approves Four New Semiconductor Projects in 2025. evrimagaci.org

23. BISinfotech. India Semiconductor Mission 2.0 Focuses on SiC Wafers. September 2025. bisinfotech.com

24. CRN Asia. India Set to Begin Commercial Chip Production by End-2025. crnasia.com

General Reference and Academic Sources

25. Wikipedia. Silicon Carbide. en.wikipedia.org

26. Encyclopaedia Britannica. Silicon Carbide: Discovery and Modern Uses. britannica.com

27. Materials Research Furnaces LLC. Silicon Carbide Then and Now. mrf-furnaces.com

28. Advanced Ceramics Hub. Silicon Carbide Properties: Hardness, Thermal Conductivity and Uses. June 2025. advceramicshub.com

29. VynzResearch. Global Silicon Carbide (SiC) Market for Electric Vehicles 2025-2030. vynzresearch.com

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All data sourced from credible industry, government, and academic references cited above. Prepared for publishing purposes.